

CLAIMS

What is claimed is:

1. Optical tweezers using laser light comprising:
at least one Vertical Cavity Surface Emitting Laser, or VCSEL,
5 supplying the laser light.

2. The optical tweezers according to claim 1 wherein the at least
one VCSEL comprises:
an array of VCSELs.

3. The optical tweezers according to claim 2
10 wherein a plurality of the VCSELs of the array simultaneously
illuminate a plurality of objects at a plurality of different
locations all at the same time.

4. The optical tweezers according to claim 2
15 wherein a plurality of the VCSELs of the array simultaneously
illuminating a single object so as to increase an optical force
imparted to the object over that optical force which would be
imparted by a illumination with laser light from a single VCSEL.

5. The optical tweezers according to claim 1 or claim 2 or claim
3 further comprising:

20 a stage (i) supporting the at least one object that is being
illuminated by the laser light of the at least one VCSEL, and (ii)
moving relative to the laser light of this at least one VCSEL;

therein serving to spatially move the at least object that is
illuminated by the laser light of the at least one VCSEL.

25 6. The optical tweezers according to claim 1 or claim 2 or claim
3 further comprising:

a source of an electric field for spatially positioning by

electrical force a same object that is illuminated by laser light from the at least one VCSEL so as to exert optical force upon this object.

7. The optical tweezers according to claim 1 or claim 2 or claim 3

wherein the at least one VCSEL emits laser light having a Laguerre-Gaussian energy distribution.

8. The optical tweezers according to claim 1 or claim 2 or claim 3 capable of manipulating an object $> 5 \mu\text{m}$ in size.

9. A method of optically trapping and tweezing comprising:
optically spatially manipulating at least object illuminated by the laser light of a vertical cavity surface emitting laser, or VCSEL.

10. The method of optically trapping and tweezing according to claim 9

wherein the optically spatially manipulating is of a plurality objects illuminated by the laser light beams of a plurality of vertical cavity surface emitting lasers, or VCSELs.

11. The method of optically trapping and tweezing according to claim 10

wherein the optically spatially manipulating is of all the trapped plurality objects simultaneously.

12. The method of optically trapping and tweezing according to claim 10

wherein the optically spatially manipulating of the trapped plurality objects is selective, with some of the plurality of objects being manipulated while others of the plurality of objects are not manipulated at all.

13. The method of optically trapping and tweezing according to claim 9 or claim 10 further comprising:

spatially moving at least one VCSEL relative to an object that is being illuminated by the laser light of this at least one VCSEL, therein spatially moving the object.

14. The method of optically trapping and tweezing according to claim 9 or claim 10 further comprising:

spatially positioning under force of an electric field the at least one object that is also optically spatially manipulated.

15. The method of optically trapping and tweezing according to claim 9 or claim 10

wherein the optically spatially manipulating by the laser light of a VCSEL is with laser light that is Laguerre-Gaussian in its power distribution.

16. The method of optically trapping and tweezing according to claim 9 or claim 10

wherein the optically spatially manipulating is of at least one object $> 5 \mu\text{m}$ in size.

17. Optical tweezers comprising:

a stage supporting a plurality of optically manipulatable objects; and

a plurality of laser light beams for concurrently optically manipulating the plurality of objects supported upon the stage.

18. The optical tweezers according to claim 17 further comprising:

a plurality of Vertical Cavity Surface Emitting Lasers, or VCSELs, originating the plurality of laser light beams.

19. The optical tweezers according to claim 17

wherein the stage supporting the plurality of objects moves

spatially relative to the plurality of laser light beams, therein simultaneously moving the plurality of objects.

20. The optical tweezers according to claim 17 further comprising:
a source an electric field for electrically manipulating the
plurality of objects supported upon the stage.

21. Optical tweezers comprising:
a stage holding an object; and
a source of multiple laser beams impinging upon the object at
the same time, therein enhancing the optical force imparted to the
object over that which would be imparted by a single laser beam.

22. The optical tweezers according to claim 11 wherein the source
of the multiple laser beams comprises:
multiple VCSELs.

23. The optical tweezers according to claim 11 wherein the
multiple VCSELs are organized in a regular geometric array.

24. Optical tweezers comprising:
a stage holding multiple objects; and
a source of multiple intensity-controllable laser beams
illuminating the multiple objects; and
a controller of the intensities of the laser beams;
wherein an optical force imparted to each of the multiple
object illuminated by the multiple laser beams may be varied in
accordance that the intensity of a corresponding one of the
multiple laser beams is varied.

25. The optical tweezers according to claim 11 wherein the source
of the multiple intensity-controllable laser beams comprises:
multiple VCSELs independently controllable in drive current;
and

wherein the controller of the intensities of the laser beams comprises:

a controller of the drive currents of the multiple VCSELs so as to produce the multiple laser beams at multiple intensities.

5 26. The optical tweezers according to claim 25 wherein the multiple drive-current-controllable VCSELs are organized in a regular geometric array.

27. Optical tweezers comprising:

10 two electrodes, at least one of which is optically transparent, holding between them at least one object suitably manipulatable both by (i) an electric field between the two electrodes and, also, (ii) an impinging laser light beam; and

15 a source of a laser beam passing through the at least one electrode that is transparent to impinge upon the at least one object so as to optically manipulate this at least one object;

wherein the at least one object is susceptible of manipulation by both electrical and optical forces.

28. The optical tweezers according to claim 27 further comprising:

20 a liquid solution between the two electrodes in which liquid solution the at least one object is maintained.

29. Optical tweezers comprising:

a source of laser light with a Laguerre-Gaussian energy distribution.

25 30. The optical tweezers according to claim 29 wherein the source of laser light comprises:

a Vertical Cavity Surface Emitting Laser, or VCSEL.

31. The optical tweezers according to claim 29 wherein the source of laser light comprises:

a source of plural laser light beams each with a Laguerre-Gaussian energy distribution.

32. The optical tweezers according to claim 31 wherein the source of plural laser light beams comprises:

5 an array of Vertical Cavity Surface Emitting Laser, or VCSELs.